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ABSTRACT

This Missouri Vocational Instruction Management System instructor's drafting guide has been keyed to the drafting competency profile developed by state industry and education professionals. The guide contains a cross-reference table of instructional materials. This unit covers geometric dimensioning and tolerancing. The unit contains the following: (1) unit and specific objectives; (2) suggested activities; (3) instructional materials; (4) unit content; (5) references; (6) instructor notes; (7) information sheets; (8) lessons; (9) transparency masters; (10) handouts; (11) assignment sheets; (12) job sheets; and (13) unit test and answers. (NLA)

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Module

9 GEOMETRIC DIMENSIONING AND TOLERANCING

70-4009-I
Instructor's Guide

ED336604

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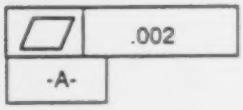

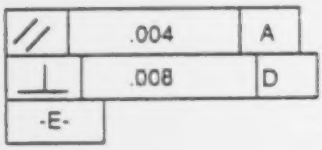

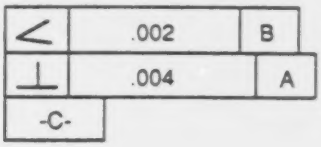

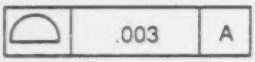

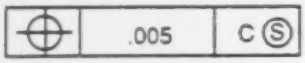

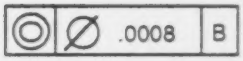

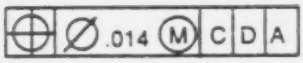

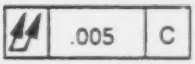

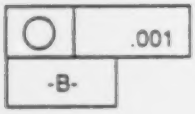

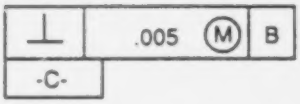

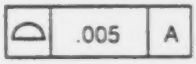

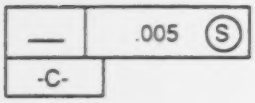

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Instructional Materials Laboratory, University of Missouri-Columbia, Columbia, Missouri

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DRAFTING

Module 9: Geometric Dimensioning and Tolerancing

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University of Missouri-Columbia
Columbia, MO 65211

1991

Instructor's Guide
Catalog N. 70-4009-I

FORWARD

Once again, we are indebted to the teachers and administrators who provided their time, effort and professionalism to develop curriculum guides for trade, technical and industrial education programs. This drafting guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, job sheets, assignments sheets and test items are keyed to specific competencies. A cross-reference table has been included to identify quickly the parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future drafting curriculum modifications will begin with this guide. The drafting field is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding ares for improvement are both encouraged and appreciated.

Judith Moore, supervisor
Industrial Education
Department of Elementary and Secondary Education

Charles "Chuck" Waibel, director
Industrial Education
Department of Elementary and Secondary Education

SPECIAL NOTE TO INSTRUCTORS CONCERNING MODULE 9, GEOMETRIC DIMENSIONING AND TOLERANCING

Module 9 is different from most of the other modules in this curriculum guide. It is based on a separate book not included in the guide. Introduction to Geometric Dimensioning and Tolerancing (see enclosed order sheet) was also developed with funding from the Department of Elementary and Secondary Education, Division of Vocational and Adult Education. The committee supervising the development of this guide decided that it would not be necessary or cost effective to duplicate work already done. You may order Introduction to Geometric Dimensioning and Tolerancing from Instructional Materials Laboratory.

Included in this module are activity sheets and a unit test along with an answer key.

ACKNOWLEDGEMENTS

This drafting guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the drafting competency profile developed by industry and education professionals in the state.

When searching for current drafting materials to adopt or use in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these drafting materials.

Special appreciation is given to the writers for their self-motivation, reliability and technical expertise.

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Support and contributions of IML staff members were instrumental to this module's development.

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Amon Herd, associate director
Phyllis Miller and Dan Stapleton, assistant directors
Betty Gibb, assistant editor
Fiona Gammonley, graphic designer

TABLE OF CONTENTS

Geometric Dimensioning and Tolerancing

Unit I: Geometric Dimensioning and Tolerancing 1

HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Drafting guide contains ten modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc., are included in the Notes to the Instructor section near the beginning of each unit.

Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

- 3 = **Mastery** - can work independently with no supervision
- 2 = **Requires supervision** - can perform job completely with limited supervision
- 1 = **Not mastered** - requires instruction and close supervision
- N = **No exposure** - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Therefore, the first objective in Lesson 1 is numbered 1.1, the second is 1.2, etc. Other components of the module (transparencies, handouts, assignment sheets and job sheets) also use this numbering system. By looking at the cross-reference table, the instructor can quickly determine what test questions or job sheets a student needs to receive an evaluation on a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives that state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc., are included in the Notes to the Instructor section.

Information sheets (color-coded green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. **CAUTION** statements indicate possible equipment damage, while **WARNING** statements recommend procedures to avoid bodily injury. Handouts and transparency masters are noted in the information sheets for instructional use.

Transparency masters (color-coded white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary, and they direct students to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion.

Handouts (color-coded white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (color-coded tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (color-coded blue)

These evaluation instruments are provided for two purposes: to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance that might be reasonably expected from a vocational student. The spaces to the right of the page on a job sheet assist the instructor in evaluating a student on a particular activity. This 3-2-1-N grading system is the same as the one used on the competency profile.

Unit test (color-coded yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), using Scantron sheets for computer-recording of test answers.

The unit test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson by lesson.
5. Give students unit test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take unit test.
5. Do job sheets.

Drafting

Module: Geometric Dimensioning and Tolerancing

Cross-Reference Table of Instructional Materials

Competency	Unit	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
H-4	1	1.1 - 1.9			1 - 4		1 - 20	

For additional support of your curriculum materials, consider the following publication.

Introduction to Geometric Dimensioning and Tolerancing - This student reference material defines geometric dimensioning and tolerancing and prioritizing datums; helps in recognizing basic geometric dimensioning and tolerancing symbols; interpreting form and orientation tolerancing; and interpreting profile, runout, and location tolerancing.

Use the handy order form below or call our toll-free number for additional information.

ORDER FORM

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Title	Catalog Number	Quantity	Unit Price	Net Price
Geometric Dimensioning and Tolerancing,	75-9513-S		$6.00	
Competency Tests/10 per pkg/ includes answers	75-9513-E		$5.00	
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MODULE: GEOMETRIC DIMENSIONING AND TOLERANCING

UNIT I: GEOMETRIC DIMENSIONING AND TOLERANCING

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify, interpret and draw the various types of symbols used in geometric dimensioning and tolerancing. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring ___ on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1.1 Match terms related to geometric dimensioning and tolerancing with their correct definitions

1.2 Identify the symbols used in geometric dimensioning and tolerancing.

1.3 Define and interpret the four form tolerances.

1.4 Define and interpret the two profile tolerances.

1.5 Define and interpret the three orientation tolerances.

1.6 Define and interpret the two runout tolerances.

1.7 Define and interpret the two location tolerances.

1.8 Draw feature control symbols for selected tolerances.

1.9 Describe tolerance requirements indicated in selected feature control frames.

MODULE: GEOMETRIC DIMENSIONING AND TOLERANCING

UNIT I: GEOMETRIC DIMENSIONING AND TOLERANCING

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the Instructor

D. Assignment sheets

AS 1.1: Identify Geometric Dimensioning and Tolerancing Symbols
AS 1.2 Identify Tolerancing Groups
AS 1.3 Feature Control Frames
AS 1.4 Geometric Dimensioning and Tolerancing

E. Answers to assignment sheets

F. Unit test

G. Answers to unit test

REFERENCES

Foster, Lowell W. Geo-Metrics II, The application of Geometric Tolerancing Techniques (using customary inch system). Reading, Mass.: Addison-Wesley Publishing Co., Inc., 1986.

Madsen, David A. Geometric Dimensioning and Tolerancing Basic Fundamentals. South Holland, Ill.: The Goodheart-Willcox Co., Inc., 1988.

Goetsch, David L. John A. Nelson, William S. Chalk. Technical Drawing. Albany, N.Y.: 1989.

American National Standard ANSI Y14.5M-1982 (Revised 1988). Dimensioning and Tolerancing. New York, N.Y.: American Society of Mechanical Engineers.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. As mentioned earlier, it is recommended that you use the book Introduction to Geometric Dimensioning and Tolerancing, available from Instructional Materials Laboratory, (see enclosed order form) to teach this module. This book is divided into four sections with a Self Review for each section. These Self Reviews could be used as supplemental assignment sheets or for a basis of class discussion.

2. Use drawings from industry and finished products as examples.

IDENTIFY GEOMETRIC DIMENSIONING AND TOLERANCING SYMBOLS

Identify the following symbols:

1.

_____

2. _____

3. _____

4. _____

5. _____

6.

_____

7. _____

8. _____

9. _____

10. _____

Draw the symbol for the following terms:

11.	Cylindricity	_____	12.	Datum target	_____
13.	Angularity	_____	14.	Profile of a line	_____
15.	Least material condition	_____	16.	Regardless of feature size	_____
17.	Diameter	_____	18.	Target point	_____
19.	Straightness	_____	20.	Position	_____

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IDENTIFY TOLERANCING GROUPS

List below the tolerances from the list on the right that control force.

1. _____
2. _____
3. _____
4. _____

Do the above tolerances require a referenced datum?

Yes_____ No_____

List below the tolerances from the list on the right that control orientation.

5. _____
6. _____
7. _____

Do the above tolerances require a referenced datum?

Yes_____ No_____

List below the tolerances from the list on the right that control rotational parts:

8. _____
9. _____

Do the above tolerances require a referenced datum?

Yes_____ No_____

List below the tolerances from the list on the right that control location:

10. _____
11. _____

Do the above tolerances require a referenced datum?

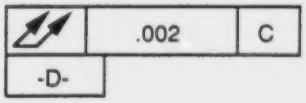
Yes_____ No_____

a. Perpendicularity
b. Total runout
c. Position
d. Circularity
e. Cylindricity
f. Profile
g. Angularity
h. Circular runout
i. Concentricity
j. Flatness
k. Straightness
l. Parallelism

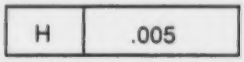
FEATURE CONTROL FRAMES

Draw the feature control symbol for each of the following tolerance requirements.

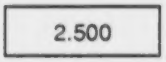
1. Cylinder "A" must be concentric to cylinder "B." Apply a runout tolerance to the entire surface of cylinder "A" within .002 to cylinder "B" which is designated as datum C. After meeting the runout requirement, cylinder "A" becomes datum D.



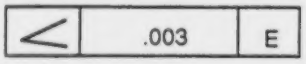
2. Cylinder "C" must be cylindrical within .005.



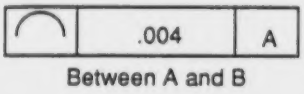
3. The 2.500" dimension locates a hole with a true position tolerance. Draw the symbol that designates the 2.500" dimension as a basic dimension.



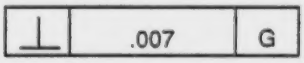
4. The 66° surface must have an angularity tolerance applied relative to datum E within .003.



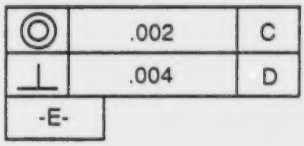
5. Apply a line profile tolerance to the top curve of the part between points "A" and "B" within .004 relative to datum A, which is the back surface of the part.



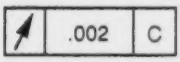
6. Apply a perpendicularity tolerance to surface "F" relative to datum G within .007.



7. Cylinder "J" must be concentric to cylinder "K." Apply a concentricity tolerance to the surface of cylinder "j" within .002 to cylinder "K" being designated as datum C. In addition, cylinder "J" must be perpendicular to flange "L," which is datum D, within .004. After meeting the concentricity and perpendicularity requirements, cylinder "J" becomes datum E.

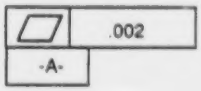


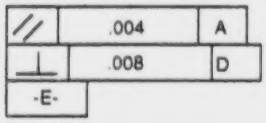
8. Apply a single line element runout tolerance to the surface of cylinder "A: within .002 with cylinder "B," which is designated as datum C.

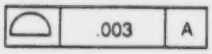


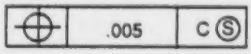
GEOMETRIC DIMENSIONING AND TOLERANCING

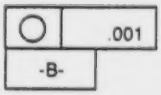
Describe the tolerance requirements indicated in the feature control frame symbols shown below.

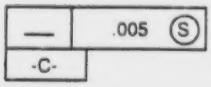
1. 

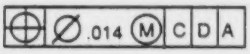
2. 

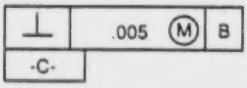
3. 

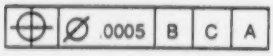
4. 

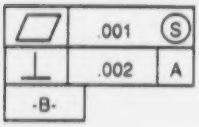
5. 

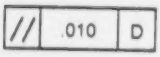
6. 

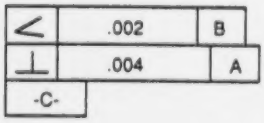
7. 

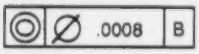
8. 

9. 

10. 

11. 

12. 

13. 

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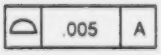
15. 

19

MODULE: GEOMETRIC DIMENSIONING AND TOLERANCING

UNIT I: GEOMETRIC DIMENSIONING AND TOLERANCING

ANSWERS TO ASSIGNMENT SHEETS

AS 1.1

1. datum
2. total runout
3. profile of surface
4. parallelism
5. concentricity
6. maximum material condition
7. flatness
8. perpendicularity
9. runout
10. Circularity
11.
12.

13.
14.
15.

16.

17.
18.
19.
20.

AS 1.2

1.	j	
2.	d	
3.	k	
4.	e	no
5.	a	
6.	g	
7.	l	yes
8.	h	
9.	b	yes
10.	c	
11.	i	yes

AS 1.3

1.

2.

3.

4.

5.

6.

7.

8.

AS 1.4

1. This surface shall be flat within .002 and then become datum "A"

2. This feature shall be parallel to datum "A" within .004. It also shall be perpendicular to datum "B" within .008 and then become datum "E."

3. Feature profile of the entire surface to be within .005 relative to datum "A."

4. Feature shall be true position within .005 to datum "C" regardless of the feature size of datum "C."

5. Feature shall be circular within .001 and then become datum "B."

6. Feature shall be straight within .005 regardless of feature size and then become datum "C."

7. Feature shall be true position within .014 diameter at maximum material condition.

8. Feature shall be perpendicular within .005 diameter at maximum material condition to datum B and then become datum "C."

9. Feature shall be in true position within .0005 diameter to datum "B," datum "C" and datum "A."

10. Surface shall be flat within .001 regardless of feature size; perpendicular within .002 to datum "A" and then become datum "B."

11. Feature shall be parallel within .010 to datum "D."

12. Feature shall be angular within .002 to datum "B" and perpendicular within .004 to datum "A," and then become datum C.

13. Feature shall be concentric within .0008 diameter to datum "B."

14. Runout of feature shall be .005 to datum "C."

15. Feature profile of the entire surface to be within .005 relative to datum "A."

MODULE: GEOMETRIC DIMENSIONING AND TOLERANCING

UNIT I: GEOMETRIC DIMENSIONING AND TOLERANCING

UNIT TEST

Match the terms on the right with their correct definitions.

___ 1. A tolerance that controls surface and axes which must be at right angles with a datum axis

___ 2. A component of a part such as a hole, slot, surface or boss

___ 3. A condition in which two parts are toleranced so that either a clearance or an interference can result when parts are assembled

___ 4. Tolerancing of a feature at a specified angle from another feature

___ 5. A condition between mating parts in which thee is always a clearance assembly

___ 6. A tolerance that allows variations only in one direction

___ 7. The composite variation from the desired form of a part surface of revolution during full rotation of the part on a datum axis

___ 8. Reference points, lines, planes, cylinders, and axes that are assumed to be exact and perfect

___ 9. A tolerance in which the axis of a feature must be coaxial to a specified datum regardless of the datum's and the feature's size

___10. A condition of a feature in which all tolerances of location, size and form are considered

___11. A tolerance that controls the allowable variation of a surface of axis from a theoretically perfect plane or line

___12. A tolerancing method showing only the maximum and the minimum dimensions that establish the limits

a. Straightness

b. Angularity

c. Form tolerance

d. Feature

e. Perpendicularity

ab. Virtual condition

ac. Concentricity

ad. Limit dimensions

ae. Runout

bc. Datums

bd. Transitional fit

be. Clearance fit

cd. Unilateral tolerance

Select the correct answer to each of the following questions.

__13. A tolerance that specifies the allowable variation of a feature from perfect form is called?
- a. Profile tolerance
- b. Orientation tolerance
- c. Size tolerance
- d. Runout tolerance
- e. Form tolerance

__14. In positional tolerancing, to what does the term "true position" refer?
- a. The approximate location of a designated feature
- b. The theoretically exact location of a feature
- c. The theoretical mid-point of a feature
- d. The theoretical exact orientation of a feature
- e. The perfect location of a basic feature

__15. A bilateral tolerance is one that is applied to a nominal dimension in what way?
- a. On the "X" and "Y" coordinates
- b. On the "y" and "Z" coordinates
- c. In the positive and negative directions
- d. In the vertical and horizontal directions
- e. Showing only the maximum and minimum dimension

__16. What is a theoretically "perfect" dimension similar to a reference dimension or nominal dimension called?
- a. Datum dimension
- b. Basic dimension
- c. True dimension
- d. Limit dimension
- e. Size dimension

__17. The variation or allowance of a dimension is known as?
- a. Flatness
- b. Straightness
- c. Concentricity
- d. Cylindricity
- e. Relativity

__18. What is a tolerance called that controls interdependent surfaces and axes that must be equal distances from a datum plane or axis?
- a. Parallelism
- b. Straightness
- c. Concentricity
- d. Cylindricity
- e. Relativity

__19. Which feature controls do not require a datum surface?
- a. Location
- b. Orientation
- c. Form
- d. Runout
- e. Symmetry

__20. When are form and positional tolerances used on a drawing?
- a. When required to make the part more expensive
- b. When required to make the part cheaper
- c. When required to make the parts exactly alike
- d. When required by the function of the part
- e. When trying to make the drawing look professional

MODULE: GEOMETRIC DIMENSIONING AND TOLERANCING

UNIT I: GEOMETRIC DIMENSIONING AND TOLERANCING

ANSWERS TO UNIT TEST

1. e
2. d
3. bd
4. b
5. be
6. cd
7. ab
8. bc
9. ac
10. ab
11. a
12. ad
13. e
14. b
15. c
16. b
17. d
18. a
19. c
20. d